IPM

An Integrated Pest Management Primer

Science and Education Administration.

U.S. Department of Agriculture, Washington, D.C. 20250

Compiled from comments of an informal working group consisting of:

James L. App
Richard D. Berger
James E. Brogdon
Robert F. Brooks
Roy R. Carriker
Richard P. Cromwell
Robert A. Dunn
Katherine C. Ewel
John F. Gerber
Freddie A. Johnson
James P. Jones
Clyde F. Kiker
Joseph L. Knapp, Jr.
Philip G. Koehler
Thomas A. Kucharek
Amegda J. Overman
Vernon G. Perry
Sidney L. Poe
Kenneth L. Pohronezny
Gary E. Sanden
Donald E. Short
Glen H. Smerage
Robert E. Stall
John R. Strayer
David H. Teem
Van H. Waddill

Joseph M. Good, Extension Service, USDA, Washington, D.C.
Gene Jackson, A. Duda and Sons, Belle Glade

Prepared for publication by

Keith Hoeller, Editor and Author
Ralph Knudsen, Illustrator
Ashley Wood, Illustrator
IFAS Editorial Department

The purpose of this primer is to inform the public and pesticide users about the principles of Integrated Pest Management. This primer was partially funded by the United States Department of Agriculture and the Environmental Protection Agency. It was developed by:

Institute of Food and Agricultural Sciences
University of Florida, Gainesville

IPM Integrated Pest Management

CONTENTS

PREFACE

This primer has as its goal the presentation of basic concepts of Integrated Pest Management for IFAS Research and faculty, Extension agents, industry representatives, agricultural producers and urban gardeners.

It is the instrument used by a committee involved in a statewide training effort of persons concerned with all phases of agricultural production and crop protection.

The committee acknowledges the monetary support of Dr. Joseph Good, Extension Service, USDA, Washington, D.C., and Drs. Vernon G. Perry, James L. App, and John F. Gerber, IFAS, University of Florida, for their interest and catalytic action. Thanks are also due to Dr. Fowden G. Maxwell, Chairman, Department of Entomology and Nematology, and Dr. Milton Morris, Chairman, IFAS Editorial, for the support of the committee and primer publication.

IFAS Pest Management Training Committee

S. L. Poe, Chairman
R. A. Dunn
T. A. Kucharek
R .R. Carriker
F. A. Johnson
J. R. Strayer
R. P. Cromwell
C. F. Kiker
D. H. Teem

I. INTEGRATED PEST MANAGEMENT: THE CONCEPT AND PRINCIPLE

Integrated Pest Management (IPM) is a relatively new approach to an old problem: How to insure crop protection and maintain yield and quality through controlling pest populations while minimizing effects on people and the environment. IPM attempts to make the most efficient use of the strategies available to control pest populations by taking action to prevent problems, suppress damage levels and use chemical pesticides only where needed. Rather than seeking to eradicate all pests entirely, IPM strives to prevent their development or to suppress their population numbers below levels which would be economically damaging.

Integrated means that a broad, interdisciplinary approach is taken using scientific principles of crop protection in order to fuse into a single system a variety of methods and tactics.

Pest includes insects, mites, nematodes, plant pathogens, weeds, and vertebrates which adversely affect crop quality and yield.

Management refers to the attempt to control pest populations in a planned, systematic way by keeping their numbers or damage within acceptable levels.

II. THE EVOLUTION OF IPM

Until recently pest control has been achieved almost exclusively by use of chemical pesticides. There were several reasons for this:

(1) Chemical pesticides provide the easiest, quickest way of reducing pest populations.
(2) The broad spectrum nature of early pesticides protected crops from a variety of pest species and a single application was often sufficient for control.
(3) Development of agricultural technology and application equipment made it economically feasible to apply pesticides, i.e., cost return benefits for chemical pesticides were maximized.

Although chemicals have been extremely beneficial in crop protection, an almost total dependence on synthetic pesticides has resulted in unintended and unforeseen problems:

(1) **Environmental Contamination.** Pesticides have aroused concern because of possible adverse effects on people and other life in the environment. Rachel Carson's book *Silent Spring* (1962) was instrumental in sounding the alarm of the potential dangers from pesticides in food and on the ecosystem. One result has been that many pesticides have been taken off the market as unsafe and thus are no longer available.

(2) **Resistance.** Several pests have developed resistance to commonly used pesticides. This resistance has rendered pesticides less effective against certain pests and shortened the useful life of the chemical. Pest resistance generally leads to (a) an increase in the amount of pesticides applied; (b) a search for newer, more effective replacement chemicals; (c) more sensible use of pesticides; or (d) a search for alternatives to pesticide usage.

(3) **Misuse of Chemical Pesticides.** Since pesticides were relatively inexpensive and easy to apply, producers often resorted to a higher number of pesticide applications than might actually be necessary in order to protect the crop. Not only was this economically unsound, it tended to increase other problems associated with pesticides.

(4) **Secondary Pest Outbreaks.** Complete control of one pest by means of pesticides often led to secondary population outbreaks. In other words, eliminating one pest would upset the ecological balance and another organism, which was previously not harmful, would emerge as a pest.

(5) **Non-target Organisms.** The broad spectrum pesticides killed not only pests, but also their natural enemies. For example, a fungus disease called Hirsutella, which persists throughout the year in nearly all citrus groves, is the most effective natural enemy of citrus mites. However, chemical pesticides are toxic to Hirsutella and will reduce its effectiveness.

(6) **Resurgence.** Using pesticides sometimes led to a resurgence of the original pest population which in turn called for the use of more and more pesticides. This often occurred because the use of pesticides would upset the ecological balance by eliminating both pests and non-target organisms (like natural enemies). Thus, any pests which survived or re-invaded would have an excellent opportunity for increasing their numbers, even to a level higher than before pesticide application because neither their natural enemies nor competitors would be present.

In addition, the emergence of the **energy crisis** has focused on the importance, high cost and ultimate scarcity of petroleum, from which synthetic chemical pesticides were derived. Not only are the chemical pesticides more expensive and subject to the availability of petroleum, energy itself is expended in vast quantities to store, distribute and apply them.

Since pesticide use is being legally restricted due to possible adverse effects on people and on the environment, and since some pesticides are becoming less effective for the variety of reasons listed above, a more comprehensive, ecologically based approach to crop protection is clearly called for. To be sure, chemical pesticides will continue to play an important role in the IPM program. The primary difference, however, is that these products will be used selectively and judiciously. The new approach, IPM, seeks to decrease the dependence on pesticides as the exclusive tool for pest control. IPM strives to meet **the present needs** of modern society and agriculture. These are:

1. Crop protection
   a. High yields
   b. Crop quality
2. Environmental quality
   a. Safeguard people's health
   b. Protect natural resources

Thus, IPM wishes to (1) protect the health and welfare of producers, workers, consumers, and society as a whole by reducing pesticide entry into the environment, i.e., the food chain, the water, the air and the soil system, and (2) to control pests in a more effective, economical, and ecologically stable manner.

III. THE GOALS OF IPM

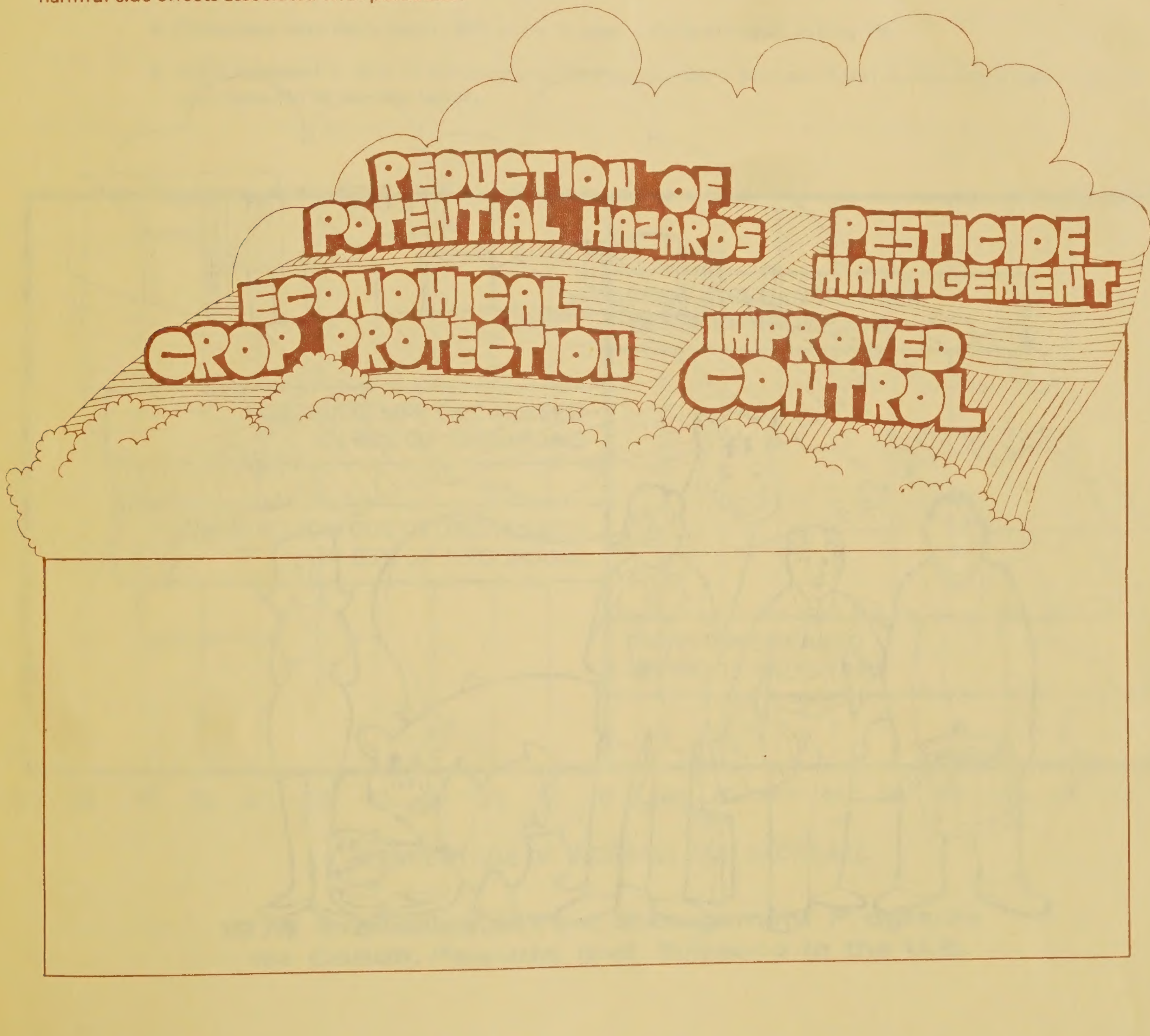
The goals of an IPM program are:

(1) **Improved Control.** IPM will provide more effective pest control to maintain and sometimes improve quality and yield. For example, by implementing alternatives to strict dependence on pesticides, IPM makes use of a balanced approach relying, for example, on cultural practices, natural enemies (parasites or pathogens) and host plant resistance as well as chemicals. By reducing the use of pesticides, IPM will be able to emphasize biological control and the conservation of natural enemies already occurring in the field. IPM may provide new weapons for the producer's arsenal against pests.

(2) **Pesticide Management.** IPM will supply a more efficient and sensible approach to pesticides, thus increasing their effectiveness and useful life span and decreasing possible adverse effects.

(3) **Economical Crop Protection.** IPM will control pest populations more economically. For example, simply by treating crops **as needed**, instead of merely by the calendar, IPM can often reduce protection costs by reducing the amount of pesticide used and the number of applications.

(4) **Reduction of Potential Hazards.** IPM will better safeguard people's health and the environment from possible harmful side effects associated with pesticides.



IV. WHO BENEFITS FROM IPM?

- **Producers** benefit from decreased production costs and by having a more balanced and effective means to control pests, and by reduced risks to crop yield and people's health.
- **Farm workers** benefit by reduced exposure to pesticides and avoid risks upon re-entry to work areas.
- **Chemical companies** benefit by having a longer, useful life for their pesticides, insofar as they may avoid a build-up of resistance to their chemicals.
- **Consumers' health** benefits by enjoying food with minimal or no pesticide residue.
- **Fish and wildlife** benefit by less exposure to pesticides in their food chain.
- **The water, the air and the soil system** will remain less contaminated from misuse of pesticides.
- **Society as a whole** will ultimately reap benefits from maintained levels of production, better quality food and an environment less contaminated by potentially dangerous chemicals.

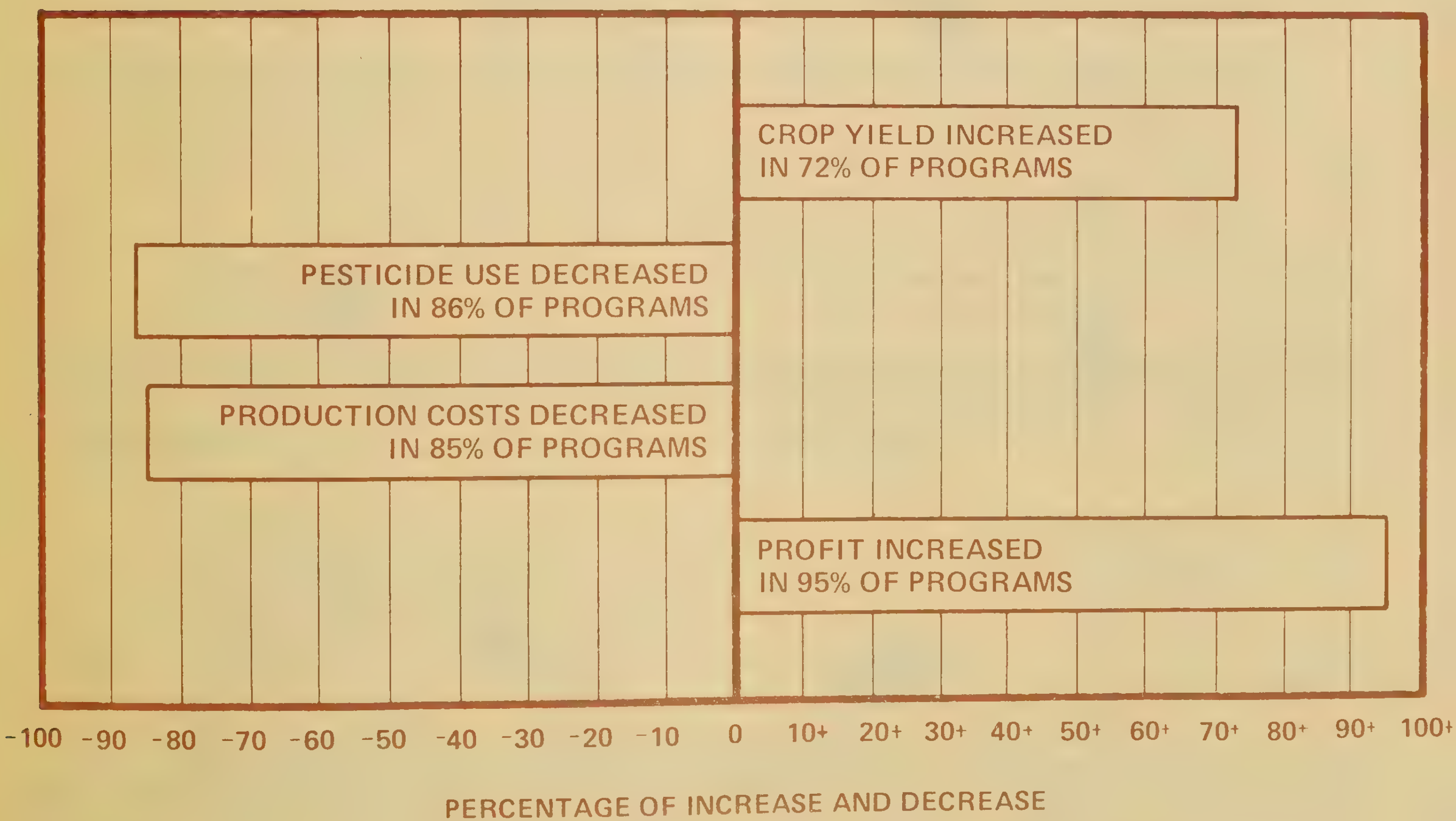
V. THE SUCCESS OF IPM: SOME EXAMPLES

IPM has been implemented and it works well on many crops. Its principles are now being applied to many others. Since 1972, the USDA Extension Service has funded more than 40 pilot programs in 33 states, involving 16 commodities (including cotton, corn, sorghum, soybeans, alfalfa, citrus, apples and peanuts), on about one million acres. Many farmers in these programs have reduced pesticide use and cost by 30-50% compared to conventional approaches:

- One South Carolina cotton farmer reduced the number of pesticide applications from 27 to 17 in 1974.
- Texas farmers reduced insecticide use on sorghum by 73%.
- New Jersey sweet corn growers cut insecticide usage by as much as 20% with no sacrifice in quality of this high value, low threshold crop (USDA #PA-1180).

In a 1975 **Evaluation of Pest Management Programs for Cotton, Peanuts, and Tobacco in the U.S.** (USDA), 25 programs were studied, indicating that:

- **Crop yield actually increased** in 72% of the programs. No farmers reported any decreases.
- **Pesticide use was decreased** in 86% of the programs. It increased in only 14%.
- **Production costs decreased** in 85% of the programs. Costs increased in only 7%.
- **Profit increased** in 95% of the programs. There was a slight decrease (5.0%) in only one program—and this was attributed to weather factors.



1975 Evaluation of Pest Management Programs for Cotton, Peanuts and Tobacco in the U.S.

The national programs have helped to increase the demand for IPM. The basic concepts have been applied to other crops and many farmers are making at least partial use of IPM principles even where a definite system has not yet been totally applied. Private consultants are utilizing IPM and farmers' cooperatives have been formed in order to benefit from IPM. Chemical companies are becoming increasingly more interested in the benefits they may derive from IPM. In addition, the Environmental Protection Agency has become involved since IPM offers an excellent solution to many of our environmental problems.

The national pilot programs have proven themselves and are now being turned into application programs. The general results of these programs indicate a reduced use of pesticides, a reduction in production costs and equivalent or greater yield when compared to conventional programs.

Overall, the IPM programs are both biologically and economically feasible. Increased profits and lower production costs have more than offset the cost of an IPM program in nearly all cases. As these projects are continually refined and re-evaluated, the predictions are for even greater success in the future.

VI. EFFECTIVE IPM

Effective IPM consists of four basic principles:

- **Exclusion** seeks to prevent pests from entering the field in the first place, thus stopping problems before they arise.
- **Suppression** refers to the attempt to suppress pests below the level at which they would be economically damaging.
- **Eradication** strives to eliminate entirely certain pests whose presence, however minimal, cannot be tolerated.
- **Plant resistance** stresses the effort to develop healthy, vigorous strains that will be resistant to certain pests.

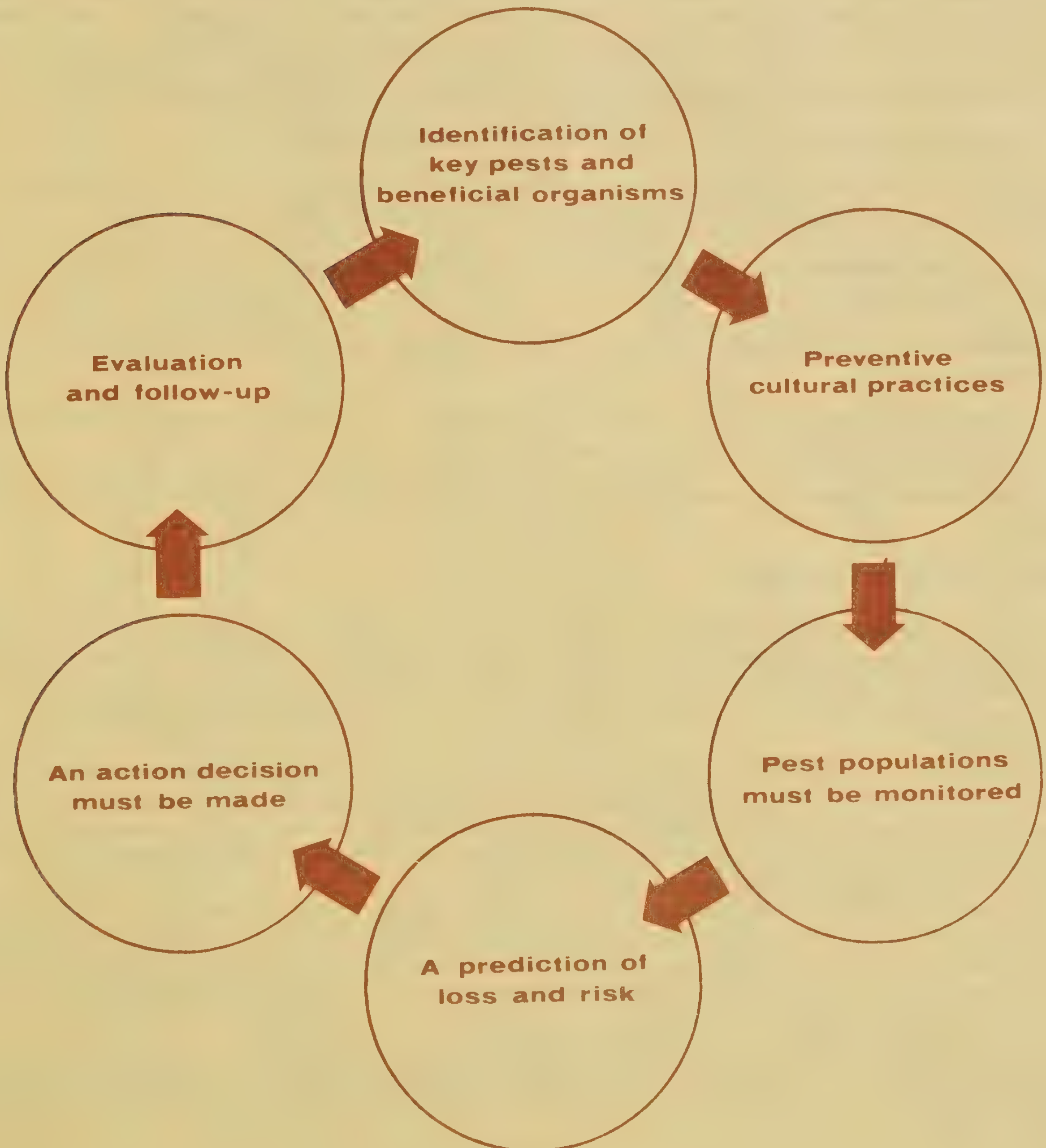
In order to carry out these four basic principles, the following steps are often taken.

(1) **The identification of key pests and beneficial organisms** is a necessary first step. In addition, biological, physical and environmental factors which affect these organisms must be ascertained.

(2) **Preventive cultural practices** are selected to minimize pest population development. These practices include soil preparation procedures, use of resistant plants, specified planting dates, etc.

(3) **Pest populations must be monitored** by trained "scouts" who routinely sample fields and fill out a scouting report.

(4) **A prediction of loss and risks** involved is made by setting an economic threshold. Pests are controlled only when the pest population threatens acceptable levels of quality and yield: Remedial action is taken. The level at which the pest population or its damage endangers quality and yield is often called the **economic threshold**. The economic threshold is set by predicting potential loss and risks at a given population density. This estimation takes in to account weather data, state of crop development, markets, risk benefit, costs and kinds of control available.



(5) **An action decision must be made.** In some cases pesticide application will be necessary to reduce the crop threat, while in other cases, a decision will be made to wait and rely on closer monitoring.

(6) **Evaluation and follow-up** must occur throughout all stages in order to make corrections, assess levels of success and to project future possibilities for improvement.

To be effective, IPM must make use of the following tools:

(1) **Pesticides.** Some pesticides are applied preventively, for example, herbicides, fungicides and nematicides. For example, proper choice of herbicides can best be made utilizing a "weed map" drawn up at the end of the season. At the beginning of the next season this map will be helpful in determining which preplant or preemergence herbicides will be most effective for the specific weeds in each field. This may dictate planting a different crop in certain fields so that the most effective herbicide can be applied. This may indicate that certain sections of the field need treatment or that rates should be varied in certain sections depending on the weed density. Likewise, soil samples can be taken to assess possible incidence of nematode populations.

In an effective IPM program pesticides are applied on a **prescription** basis tailored to the particular pest, and chosen so as to have minimum impact on people and the environment. They are applied only when a pest population has been diagnosed as large enough to threaten acceptable levels of yield and quality. Pesticides are usually chosen only after all other feasible alternatives have been considered.

(2) **Resistant crop varieties** are bred and selected when available in order to protect against key pests.

(3) **Natural enemies** are used to regulate the pest population whenever possible.

(4) **Pheromone (sex lure) traps** are used to lure and destroy male insects, thus helping monitoring procedures. Pheromone traps have control potential and have been used to keep a population within acceptable levels.

(5) **Preventative measures** such as soil fumigation for nematodes and assurance of good soil fertility help to provide a healthy, virorous plant.

(6) **Avoidance** of peak pest populations can be brought about by a change in planting times or pest controlling crop rotation.

(7) **Improved application** by keeping equipment up to date and in excellent shape can be achieved through reliance on accurate pressure, timing, agitation, etc.

(8) **Other assorted cultural practices** such as flooding, row spacing, plot spacing, can influence pest populations.

VII. HOW TO IMPLEMENT IPM

If you wish to implement an IPM program you should begin by calling your local county Extension Office. The county agent will then put you into contact with knowledgeable people in the community as well as Extension specialists trained in IPM who can help you implement an effective IPM program. Private consulting firms may also have experience in IPM and be able to provide a wide range of services. It may also be possible to become part of an existing IPM project.

Education is of prime importance to the success of implementing an IPM program. Participating growers must be convinced that IPM has something to offer in order to insure participation. Growers are concerned that it be economical over the short run or at least hold promise of alternatives which will help maintain yield and quality. As more and more pesticides are removed from use, farmers will be looking for alternatives to total dependence on pesticides and should be encouraged to explore the potential of IPM.

The county Extension agent and specialist or private consulting firm can help assess a producer's needs and form a comprehensive planning program. IPM can be as simple as scouting fields to increase spray efficiency or as complex as a growers' co-op handling everything from scouting to purchase and application of pesticides and other means of controlling pests. A growers' co-op using IPM can of course save money by purchasing in high volume as a group or by hiring its own supervisors and scouts.

Financial arrangements need to be worked out in advance. The USDA/Extension pilot projects have helped to pay for some costs but as the projects continue the growers have assumed more of the costs, such as scouting labor and travel. It should again be emphasized that in almost all cases growers have profited from IPM and recovered the costs of such a program.

Legal aspects need to be taken into account and contracts drawn up. While there have been no cases where lawsuits have been filed as a result of an IPM program, there are liabilities that need to be considered and prepared for.

An evaluation system needs to be set up to continuously improve and correct the program.

A **system** must be designed, perhaps with the use of computers, and including such factors as weather data, key pests, possible solutions, economic thresholds and risk factors, etc.

Scouts provide basic monitoring in an IPM program. A scout training program will need to be implemented. Often high school students, 4-H and FFA members can be trained to monitor the fields, sampling pests and recording pest population numbers. The scouts will need regular schedules in which they go into sample areas of the field and literally shake off the insects into a "shake cloth." (Although the monitoring procedures are different for insects, diseases, weeds and nematodes, the same basic concepts still apply). Thus, recording the number of pests in a given sample, the scouts provide important data for diagnosing the problem. Data should be accumulated and stored so that often several situations might be predicted from previous experience. Computers can serve well to integrate data of weather, crop growth and pest populations.

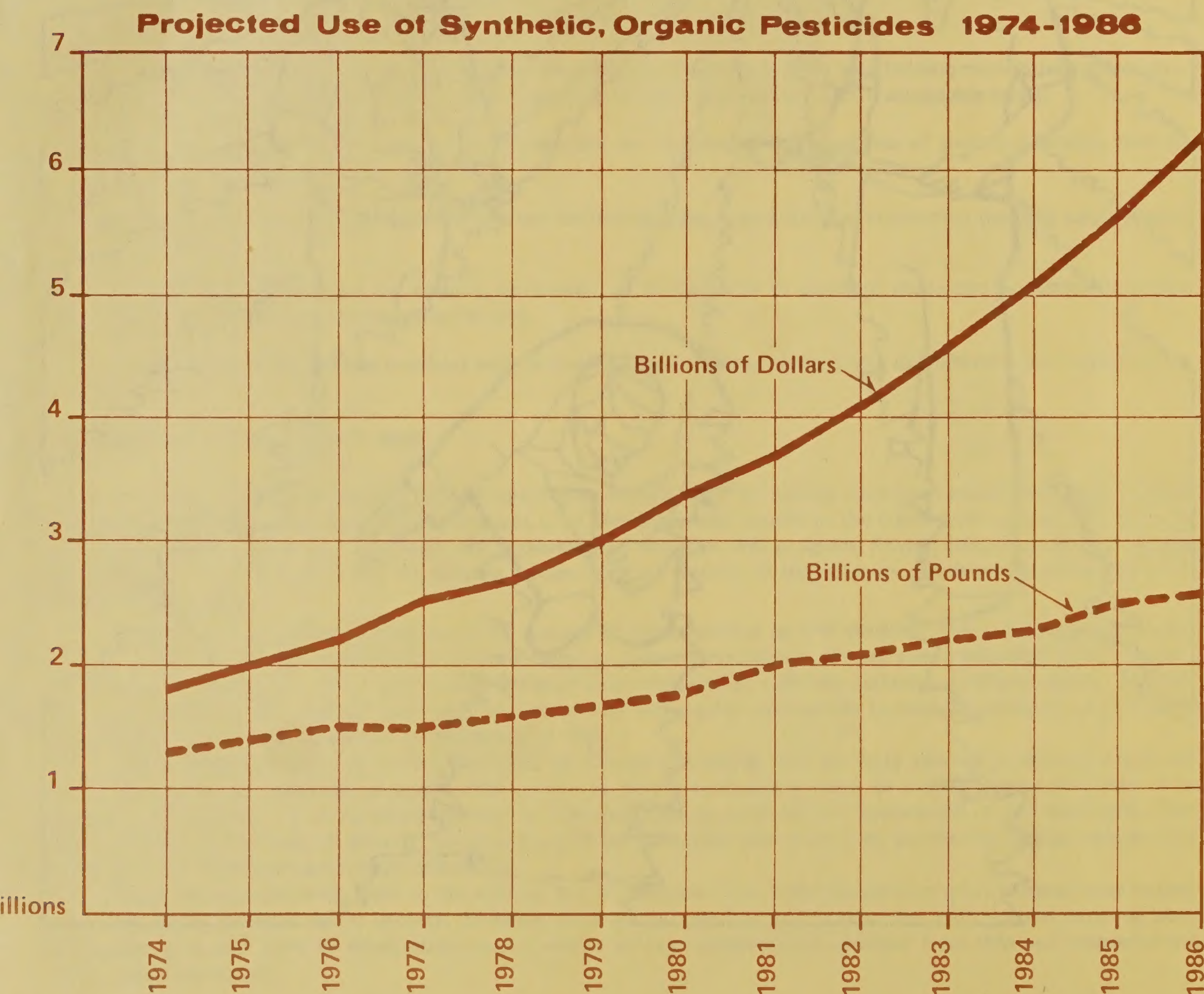
Scouts, however, do not make recommendations. Economic thresholds determined in advance will provide clues for action. Usually, an IPM specialist will make recommendations to the grower, or a committee of growers, who will then decide what action to take.

Thus, an organizational system needs to be devised encompassing scouts, specialists and growers. And of course a constant feedback mechanism from growers to specialists to scouts is part of the overall evaluation process that should be set up at all levels. By planning a total system with agents, specialists, growers and/or private firms, an economical and ecologically sound IPM program can be implemented.

VIII. THE FUTURE OF IPM

Although IPM concepts have already proven themselves, much research needs to be done. Economic thresholds are needed for many crops. Computer programs are required to integrate the vast material and data needed for simulation, prediction and control. It may be possible to develop non-human or automated scouting equipment. Weather and geographic data need to be taken into account. Further legal aspects need to be explored. And ultimately, IPM will become more efficient and economical.

Pesticide sales in 1974 alone were $1.8 billion (1.3 billion pounds). Without IPM, the USDA predicts they will increase to $6.3 billion or 2.6 billion pounds. Within 12 years an effective nationwide IPM program could reduce these sales by 30%—a savings to growers of $1.8 billion (or .8 billion pounds). The net savings over costs for the IPM programs would amount to $1.2 billion annually—plus a better, safer environment.



While there is much that remains to be done, many large steps have already been taken. Much has been learned, and the integrated approach is being used on a limited scale against specific pests. Crop protection is a vital part of the food production process. Pest control is important to community health and welfare, to household management, and to urban lawns and gardens. A more judicious, better informed use of all existing control measures in a systems context promises to reduce environmental hazards and yield significant benefits for everyone from the farmer to the consumer.

R0000 893160

The Extension Service of the U.S. Department of Agriculture offers its programs to all eligible persons regardless of race, color, or national origin, and is an equal opportunity employer.

Cooperative Extension Work: United States Department of Agriculture and State Land Grant Universities Cooperating.